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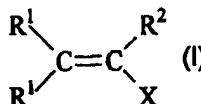
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- (71) Applicant: THE PROCTER & GAMBLE COMPANY
[US/US]; One Procter & Gamble Plaza, Cincinnati, OH
45202 (US).
- (72) Inventors: HAMERSKY, Mark, William; 6606 Chan-
dler Way, Hamilton, OH 45011 (US). SMITH, Steven,
Daryl; 5238 Concord Mill Place, Fairfield, OH 45014
(US).
- (74) Agents: REED, T., David et al.; The Procter & Gam-
ble Company, 5299 Spring Grove Avenue, Cincinnati, OH
45217-1087 (US).
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(54) Title: SYSTEMS FOR CONTROLLING PLANT AND FLOWER MOISTURE TRANSPIRATION RATES



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(57) Abstract: The present invention relates to a system for controlling plant and flower moisture transpiration and thereby extending the period of time in which cut flowers can be displayed before senescence produces a flower which has exceeded its aesthetic value. The systems of the present invention comprise: a) a first component in the form of a solution, said solution applied to the surface of a plant or flower exposed to air, said first component comprising: i) from about 0.1 % to about 20 % by weight, of a polymer of copolymer comprising monomers having the formula (I) wherein each R¹ is independently hydrogen, C₁-C₁₂ alkyl, C₁-C₁₂ alkoxy, phenyl, substituted phenyl, benzyl, substituted benzyl, carbocyclic, heterocyclic, and mixtures thereof; R² is hydrogen, halogen, C₁-C₁₂ alkyl, C₁-C₁₂ alkoxy, phenyl, substituted phenyl, benzyl, substituted benzyl, carbocyclic, heterocyclic, and mixtures thereof; X is hydrogen, hydroxyl, halogen, -(CH₂)_mCH₂OH, -(CH₂)_mCOR, -(CH₂)_mCH₂OCOR', wherein R is -OR', -N(R')₂, -(CH₂)_nN(R'')₂, and mixtures thereof; each R' is independently hydrogen, C₁-C₈ alkyl, C₂-C₈ hydroxyalkyl, -(CH₂)_nN(R'')₂, and mixtures thereof; wherein R'' is independently hydrogen, C₁-C₄ alkyl, and mixtures thereof; the index m is from 0 to 6, the index n is from 2 to 6; ii) from about 0.01 % to about 5 % by weight, of a surfactant; iii) the balance carriers and other adjunct ingredients; and b) a second component comprising: i) from about 0.1 % by weight, of a source of energy; ii) from about 5 ppm by weight, of one or more antimicrobials; and iii) the balance carriers and adjunct ingredients; wherein said second component is dissolved in water to form a solution and into which solution is placed the plant or flower to be preserved.

SYSTEMS FOR CONTROLLING PLANT AND FLOWER MOISTURE TRANSPIRATION RATES

This Application claims priority to United States Provisional Patent Application Serial Number 60/176,181 filed January 14, 2000.

FIELD OF THE INVENTION

The present invention relates to a system for controlling plant and flower moisture transpiration rates and thereby providing a system for extending the time in which plants and cut flowers can be utilized in aesthetic displays or floral arrangements.

BACKGROUND OF THE INVENTION

Flowers have been inextricably linked to human culture since antiquity. Flowers have come to represent various aspects of life and to represent various facets of the human condition. As symbols of our society they speak directly. Flowers are never out of place regardless of the circumstances, *inter alia*, births, funerals, weddings, memorials.

Humans have cultivated and propagated flowers solely for their aesthetic value since most flowers are inedible. *Incunabula* describe various techniques for cutting and preserving flowers, *inter alia*, oriental flower varnishing, dipping blossoms into waxes or wax-like solutions. Contemporary practices include fashioning artificial flowers and blossoms from synthetic material, most notably polymers. However, all of these methods for preserving flowers, or attempts at flower imitation, fails to reproduce or replace the freshness of newly cut flowers.

The prior art has attempted to provide methods of preserving cut flowers in a fresh state, but the means are inadequate to provide flowers in a nearly original state for an enhanced period of time, for example, two to five times the expected period of use.

There is, therefore, a long felt need to provide the consumer or the grower of flowers which are to be cut and displayed for aesthetic purposes, with a system with significantly extends the duration in which the cut flowers maintain their original appearance.

SUMMARY OF THE INVENTION

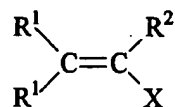
The present invention meets the aforementioned needs in that it has been surprisingly discovered that cut flowers can be preserved in a nearly original state for an extended period of

time, in fact, in some instances a period which eclipses their aesthetic utility. It has been surprisingly discovered that by creating a "post-harvest viability equilibrium" flowers can be cut and displayed without the pejorative effects of natural demise (senescence), *inter alia*, wilting (epinasty) or loss of petals, browning or discoloration of flower parts. This post-harvest viability equilibrium can be suitably established by controlling the two aspects of the flower moisture transpiration cycle; moisture uptake and moisture transpiration rate.

Flowers are ubiquitous in that they can adapt to environmental or ecological stresses. For example, during times of drought or other circumstances of water deprivation, flowers regulate their growth to attenuate the effects which this moisture deprivation stress might have on their viability. This ability to self regulate their growth cycle ameliorates many of the pejorative consequences of water deprivation on flower survival. Once flowers are cut during harvesting, the natural regulatory systems, *inter alia*, respiration, water regulation, are abated. It has been surprisingly discovered that an artificial level of viability can be re-established by a system which controls the plant water intake/evaporation cycle. Although insufficient to induce or sustain reproductive viability, i.e. the production of pollen, seeds, etc., this system, nevertheless, maintains cut flowers in their natural condition for extended periods of time without the induction of discoloration, wilting, and petal loss.

The first aspect of the present invention relates to a system for controlling plant and flower moisture transpiration, said system comprising:

- a) a first component in the form of a solution, said solution applied to the surface of a plant or flower exposed to air, said first component comprising:
 - i) from about 0.1% to about 20% by weight, of a homopolymer of copolymer comprising monomers having the formula:



wherein each R^1 is independently hydrogen, $\text{C}_1\text{-C}_{12}$ alkyl, $\text{C}_1\text{-C}_{12}$ alkoxy, phenyl, substituted phenyl, benzyl, substituted benzyl, carbocyclic, heterocyclic, and mixtures thereof; R^2 is hydrogen, halogen, $\text{C}_1\text{-C}_{12}$ alkyl, $\text{C}_1\text{-C}_{12}$ alkoxy, phenyl, substituted phenyl, benzyl, substituted benzyl, carbocyclic, heterocyclic, and mixtures thereof; X is hydrogen, hydroxyl, halogen, $-(\text{CH}_2)_m\text{CH}_2\text{OH}$, $-(\text{CH}_2)_m\text{COR}$, $-(\text{CH}_2)_m\text{CH}_2\text{OCOR}'$, wherein R is $-\text{OR}'$, $-\text{N}(\text{R}')_2$, $-(\text{CH}_2)_n\text{N}(\text{R}'')_2$, and mixtures thereof; each R' is

independently hydrogen, C₁-C₈ alkyl, C₂-C₈ hydroxyalkyl, -(CH₂)_nN(R'')₂, and mixtures thereof; wherein R'' is independently hydrogen, C₁-C₄ alkyl, and mixtures thereof; the index m is from 0 to 6, the index n is from 2 to 6;

- ii) from about 0.01% to about 5% by weight, of a surfactant;
- iii) the balance carriers and other adjunct ingredients; and
- b) a second component comprising:
 - i) from about 0.1% by weight, of a source of energy;
 - ii) from about 5 ppm by weight, of one or more antimicrobials; and
 - iii) the balance carriers and adjunct ingredients;

wherein said second component is dissolved in water to form a solution and into which solution is placed the plant or flower to be preserved.

The present invention further relates to systems which can be adjusted by the formulator to meet certain use criteria, *inter alia*, preservation of cut flowers wherein either the first component or the second component is adjusted in a timely manner or wherein one or both components are applied only in a single instance or by way of a limited schedule.

Another aspect of the present invention is a means for selecting the elements which comprise the components of the present invention. For example, selection of which polymers are suitable for use in providing the benefits of the present invention.

These and other objects, features, and advantages will become apparent to those of ordinary skill in the art from a reading of the following detailed description and the appended claims. All percentages, ratios and proportions herein are by weight, unless otherwise specified. All temperatures are in degrees Celsius (° C) unless otherwise specified. All documents cited are in relevant part, incorporated herein by reference.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a system for controlling plant and flower moisture transpiration rates and thereby providing a system for extending the time in which plants and cut flowers can be utilized in aesthetic displays or floral arrangements. The present invention is achieved by controlling the intake of water and nutrients by a cut flower. The first component of the systems of the present invention provide a control over the loss of water by the plant through transpiration. The second component of the systems of the present invention provide a source of

energy and water to the cut flower while controlling the growth of microbes and the calcium ion flux produced by the plant.

Without wishing to be limited by theory it has been found that control of the evaporation of water from cut flowers contributes to the enhanced duration with which flowers appear in their pre-harvested state. It has also been surprisingly discovered that a certain class of anti-microbial will abate the growth of microbes which serve to diminish the viability of cut flowers. However, prior art antimicrobials, *inter alia*, 8-hydroxy quinoline citrate actually enhances the growth of microorganisms after an initial diminution of their level. The pejorative consequences of microorganism growth in the display water (i.e. vase water) is not solely related to the aesthetics of the solution into which the flowers are placed, for example, milky appearance, formation of sediments, but instead the microorganisms occlude the xylem of the flower stem thereby attenuating the uptake of water and nutrients.

It has also been surprisingly discovered that once a post-harvest viability equilibrium has been established by providing a first component which regulates water transpiration from the non-immersed plant surface and a second component which provides a source of energy and preferably a means for attenuating microbial growth, a cut flower begins to establish an equilibrium concentration of calcium ions between the plant cell and the interstitial water. It is necessary to regulate this equilibrium and this can be accomplished by the presence of a water clarification agent. Therefore, depending upon the composition of the source water used to make up the solution of the second component, the amount of calcium sequestration will vary as an element of the second component.

The following is a detailed description of the elements which comprise the present invention.

MOISTURE TRANSPIRATION CONTROL SYSTEMS

First Component

The first component of the moisture transpiration control systems of the present invention is a solution which is applied to the surface of a plant or flower which would not normally be immersed into a solution which contains the second component of the present invention. The first component solution can be delivered to the air exposed surface of the flower or plant by any suitable means. Non-limiting examples of delivery of the first component include, spraying by means of aerosol, or pump, direct immersion, and variations which combine elements of immersion and spraying. The elements which comprise the first component, in selected embodiments or

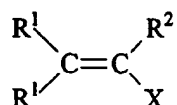
utilization of the present invention, may be added in a sequence. For example, for certain plant morphologies, the first component may be divided into a pre-treatment component and a polymer comprising component. The pre-treatment component may comprise a carrier which wets the surface of the plant or flower such that the polymer component is uniformly applied. In other sequential embodiments, a surface modifying material, *inter alia*, surfactant, may be first applied to facilitate an even dispersion of the polymeric element. However, surfactants and other optional ingredients can be directly combined with the polymeric material.

Polymer

The first component of the present invention comprises a copolymer which when applied to the air-exposed surface of a cut plant or flower produces a barrier having a water vapor transfer rate capable of establishing a moisture equilibrium which attenuates the onset of senescence and extends the duration of aesthetic utility for said cut plant or flower.

For the purposes of the present invention the term "polymer" is herein defined as "an oligomer, homo-polymer, co-polymer, or mixtures thereof which satisfy the herein described requirements for establishing a moisture equilibrium in the cut flower or plant". The polymers of the present invention may comprise any polymeric material which satisfactorily regulates the water vapor transfer rate of the plant or flower to which it is applied.

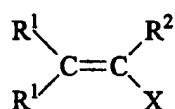
In one embodiment of the present invention, the polymers are co-polymers which are formed from one or more "vinyl monomers" having the formula:



wherein each R^1 is independently hydrogen, $\text{C}_1\text{-C}_{12}$ alkyl, $\text{C}_1\text{-C}_{12}$ alkoxy, phenyl, substituted phenyl, benzyl, substituted benzyl, carbocyclic, heterocyclic, and mixtures thereof; R^2 is hydrogen, halogen, preferably chlorine or fluorine, $\text{C}_1\text{-C}_{12}$ alkyl, $\text{C}_1\text{-C}_{12}$ alkoxy, phenyl, substituted phenyl, benzyl, substituted benzyl, carbocyclic, heterocyclic, and mixtures thereof; X is hydrogen, hydroxyl, halogen, $-(\text{CH}_2)_m\text{CH}_2\text{OH}$, $-(\text{CH}_2)_m\text{COR}$, $(\text{CH}_2)_m\text{CH}_2\text{OCOR}'$ wherein R is $-\text{OR}'$, $-\text{N}(\text{R}')_2$, $-(\text{CH}_2)_n\text{N}(\text{R}'')_2$, and mixtures thereof; each R' is independently hydrogen, $\text{C}_1\text{-C}_8$ alkyl, $\text{C}_2\text{-C}_8$ hydroxyalkyl, $-(\text{CH}_2)_n\text{N}(\text{R}'')_2$, and mixtures thereof; wherein R'' is independently hydrogen, $\text{C}_1\text{-C}_4$ alkyl, and mixtures thereof; the index m is from 0 to 6, the index n is from 2 to 6. Non-limiting examples of preferred vinyl monomers include, ethylene, propylene, butylene, styrene, vinyl alcohol, crotyl alcohol, acrylic acid, styrylacetic acid, methacrylic acid, crotonic acid, 3,3-

dimethyl-acrylic acid, methyl acrylate, ethyl acrylate, n-propyl acrylate, isopropyl acrylate, butyl acrylate, methyl methacrylate, ethyl methacrylate, n-propyl methacrylate, isopropyl methacrylate, butyl methacrylate, methyl 3,3-dimethyl-acrylate, ethyl 3,3-dimethyl-acrylate, n-propyl 3,3-dimethyl-acrylate, isopropyl 3,3-dimethyl-acrylate, butyl 3,3-dimethyl-acrylate, acrylamide, N-methyl acrylamide, N,N-dimethyl acrylamide, N-(aminoethyl) methyl acrylamide, vinyl acetate, and mixtures thereof.

In another embodiment of the present invention, the polymers are homopolymers which are formed from one or more "vinyl monomers" having the formula:



wherein R^1 , R^2 , and X are defined herein above.

In another embodiment of the present invention, a mixture of homopolymers and copolymers are used.

One embodiment comprises polymers having a water vapor transfer rate of less than 10 g-mm/m²-day, while other embodiments required a rate of 5 g-mm/m²-day. However, formulators may restrict the water vapor transfer rate to 2 g-mm/m²-day in preparing other suitable embodiments. Suitable means for determining water vapor transmission rates of polymers is by ASTM D1653 for a 0.02 inch (20 mill) film, ASTM E-96-66, Procedure E at 90% relative humidity and 100 °F for a 1 mm or 2 mm film, or TAPPI T 464 os-79 for a 2 mm film.

Copolymers of the present invention further have a glass transition temperature, T_g , greater than about 30 °C, but other embodiments have T_g values greater than about 40 °C, yet other embodiments will have polymers with T_g greater than about 60 °C. The glass transition temperature, T_g , of a particular co-polymer can be approximated beforehand by the Fox formula (T. G. Fox, *Bull. Am. Phys. Soc.*, vol. 1 123 (1956) included herein by reference):

$$\frac{1}{T_{Co}} = \frac{W_1}{T_1} + \frac{W_2}{T_2} + \dots + \frac{W_n}{T_n}$$

wherein W_1 represents the weight portion of monomer 1, W_2 represents the weight portion of monomer 2, T_1 the glass transition temperature of the polymerized monomer 1 in °K, T_2 the glass transition temperature of the polymerized monomer 2 in °K, T_{Co} , the glass transition temperature of the copolymer in °K.

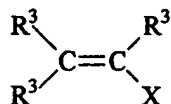
The formulator can readily establish whether a copolymer will satisfy the requirements of vapor transfer rate and glass transition temperature as set forth herein above. A plot of the glass

transition temperature, T_g , expressed in °C of the copolymer along the x axis (ordinate) versus the water vapor transfer rate expressed in g-mm/m²-day (measured or calculated) along the y axis (abscissa) preferably falls to the left of the line defined by the equation:

$$y = -0.068443x + 10.$$

Points which fall to the right of said equation will have a permeability ineffective in establishing a suitable moisture barrier at a desirable glass transition temperature. Points which fall to the right of said equation may also produce films having no ability to form an aesthetically suitable surface. For example, too high of a glass transition temperature leads to hard and/or brittle films which may detract from the aesthetic qualities which are desirable. When formulating certain embodiments of the present invention, the water vapor transfer rate and glass transition temperature are adjusted such that the applied polymer produces a clear, colorless, translucent, and transparent film.

Another embodiment of the present invention relates to "crosslinkable vinyl monomers" having the formula:



wherein X is the same as defined herein above; R^3 is R^1 , $-(CH_2)_mCH_2OH$, $-(CH_2)_mCO_2R'$ wherein each R' is independently hydrogen, C_1 - C_8 alkyl, and mixtures thereof; the index m is from 0 to 6. Non-limiting examples of "crosslinkable vinyl monomers" include maleic acid, fumaric acid, itaconic acid, citraconic acid, hydromuconic acid, and mixtures thereof.

The following are examples of non-limiting embodiments of the present invention:

- a) a composition comprising from about 0.1% by weight, of a polymer;
- b) a composition comprising from about 1% by weight, of a polymer;
- c) a composition comprising from about 2% by weight, of a polymer;
- d) a composition comprising from about 2.5% by weight, of a polymer;
- e) a composition comprising up to about 5%, by weight, of a polymer;
- f) a composition comprising up to about 7%, by weight, of a polymer;
- g) a composition comprising up to about 10%, by weight, of a polymer;
- h) a composition comprising up to about 20%, by weight, of a polymer.

The polymer can be obtained for use in any form, for example, as a dispersion in the reaction (polymerization) solvent, or the polymer can be provided as a solid. In one variation of the present invention some of carboxylic acid residues, acrylic acid, *inter alia*, which comprise the

polymers of the present invention will be neutralized. For example, the following are non-limiting examples of the embodiments which relate to neutralization of the acid groups:

- a) a composition wherein from about 1% of said carboxylic acid residues are neutralized in said polymer;
- a) a composition wherein from about 5% of said carboxylic acid residues are neutralized in said polymer;
- a) a composition wherein from about 10% of said carboxylic acid residues are neutralized in said polymer;
- a) a composition wherein to about 100% of said carboxylic acid residues are neutralized in said polymer;
- a) a composition wherein to about 50% of said carboxylic acid residues are neutralized in said polymer;
- a) a composition wherein from about 20% of said carboxylic acid residues are neutralized in said polymer;
- a) a composition wherein from about 15% of said carboxylic acid residues are neutralized in said polymer;

Suitable means for neutralization includes the use of bases, non-limiting examples of which include alkaline metal hydroxides, *inter alia*, sodium hydroxide, alkaline earth metal hydroxides, *inter alia*, calcium hydroxide, ammonia, and mixtures thereof. The degree of neutralization typically depends upon the selected monomers which comprise the polymer and which properties must be adjusted to insure the application of an homogeneous film which achieves the required glass transition temperatures and vapor transmission rates described herein.

The first components comprise a polymer, in one embodiment a copolymer, in another embodiment a homopolymer, in other embodiments mixtures thereof, which are solublized in a carrier. As described herein below, the carrier is preferably water together with one or more alcohol co-solvents. Some polymers which comprise one or more carboxylic acid monomers can be made water soluble or water dispersible by converting all or some of the carboxylic acid residues to carboxylic acid salts by treatment with base. It will be appreciated by the formulator that the water vapor transfer rates of the polymers will be related to the hydrophilicity of the polymers; the more hydrophilic a polymer the higher the water vapor transfer rate. It is preferred, for aesthetic purposes, that the polymers of the present invention when applied to the plant surface form a clear, colorless, translucent, and transparent membrane. Therefore, it is preferable that the polymers of

the present invention when utilizing this embodiment are delivered via the carrier solution such that evaporation of the carrier solution leads to formation of a homogeneous polymer layer rather than "clumping" due to differential spreading along the flower surface.

An example of a suitable copolymer comprises the reaction product obtained when polymerizing:

- i) from about 20% to about 60% by weight, of methyl methacrylate;
- ii) from about 20% to about 60% by weight, of butyl acrylate; and
- iii) from about 0.5% to about 20% by weight, of acrylic acid.

Another copolymer comprises the reaction product obtained when reacting:

- i) from about 40% to about 50% by weight, of methyl methacrylate;
- ii) from about 40% to about 50% by weight, of butyl acrylate; and
- iii) from about 5% to about 15% by weight, of acrylic acid.

A further example of a copolymer suitable for use in the present invention comprises:

- i) about 43% by weight, of methyl methacrylate;
- ii) about 47% by weight, of butyl acrylate; and
- iii) about 10% by weight, of acrylic acid.

Each of the above embodiments, neutralization of the acrylic acid residues can be achieved with a suitable base, for example, at least 5%, or in another case 10% of the acrylic acid residues.

Any suitable process can be used to form the compositions according to the present invention. However, it has been surprisingly discovered that the following process allows for the efficient formation of the polymeric solutions without phase separation. The process of the present invention comprises the steps of:

- a) dissolving a solid polymeric material free from solvents in the alcohol portion of the carrier;
- b) neutralizing acid residues to the desired level by adding dropwise an aqueous solution of base, preferably sodium hydroxide, more preferably 30% by weight sodium hydroxide;
- c) adding at a rate of from 0.1% of the water which comprises the balance of the carrier to 10% of the water which comprises the balance of the carrier per minute; and
- d) adding the surfactant.

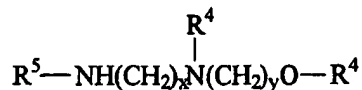
The process of the present invention, starting from a latex, comprises the steps of:

- a) adding to an aqueous latex of a polymer comprising from about 25% to about 70% solids, an alcohol or other co-solvent to form a diluted latex;
- b) neutralizing acid residues of the polymer which comprises said polymer to the desired level by adding dropwise an aqueous solution of base, preferably sodium hydroxide, more preferably 30% by weight sodium hydroxide;
- c) adding at a rate of from 0.1% of the water which comprises the balance of the carrier to 10% of the water which comprises the balance of the carrier per minute; and
- d) adding the surfactant.

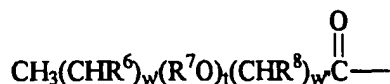
Surfactant

The first component of the present invention comprises a surfactant. The amount of said surfactant is predicated on the desired properties of the final delivery which is modifiable by the formulator. In a broad embodiment the compositions of the present invention comprise from about 0.01% by weight of surfactant, however, other embodiments will comprise from about 0.05%, or from about 0.1%. The formulator may choose the upper limit of surfactant to be about 5%, but about 2%, and even about 0.5% by weight, of a surfactant is suitable in executing the desirable compositions and embodiments of the present invention. This range of from about 0.01% to about 5% gives the formulator an opportunity to adjust the final compositions. Amounts of surfactant below 0.01% and above 5% by weight, are outside the scope of the present invention. The suitable surfactants of the present invention are surfactants which are capable of evenly wetting the surface of plants and which do not cause browning or other adverse reactions to the plant surface.

The preferred surfactants of the present invention have the formula:



wherein R^4 is $\text{---(CH}_2\text{)}_z\text{CO}_2\text{M}$, $\text{---(CH}_2\text{)}_z\text{SO}_3\text{M}$, $\text{---(CH}_2\text{)}_z\text{OSO}_3\text{M}$, $\text{---(CH}_2\text{)}_z\text{PO}_3\text{M}$, and mixtures thereof; preferably $\text{---(CH}_2\text{)}_z\text{CO}_2\text{M}$, and mixtures thereof. The index z is from 1 to 10, preferably 2 to 4, more preferably 2 or 3. M is hydrogen or a salt forming cation, preferably sodium or potassium, more preferably sodium. The indices x and y are each independently an integer from 2 to 6; preferably 2 or 3 more preferably 2. In a preferred embodiment the indices x and y are equal to each other. R^5 is an acyl unit having the formula:



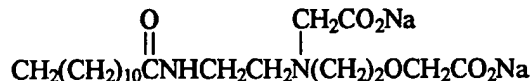
wherein R^6 and R^8 are each independently hydrogen, C_1 - C_4 alkyl, and mixtures thereof; R^7 is C_2 - C_{12} alkylene; t is from 0 to 10; the indices w' and w'' are each independently from 0 to 14, $w' + w'' =$ at least 6.

Preferably R^5 has the formula:



wherein R^4 is $-(\text{CH}_2)_z\text{CO}_2\text{M}$, and mixtures thereof; the y is equal to 2 or 3; the index y is equal to the index z . The index w' is at least 6, preferably from 8, more preferably from 10 to 14, preferably to 12.

A non-limiting example of a preferred surfactant according to the present invention is disodium lauroampho diacetate having the formula:



available ex Rhodia as Miranol® Ultra 32.

The surfactants suitable for use in the present invention are surfactants which do not cause browning of flower petals. A 0.01% by weight, aqueous solution of a linear alkyl benzene sulphonate (LAS) is sprayed onto a control flower. Preferably white carnations are selected as the control and test flower. The amount of flower browning which is present after 48 hours is taken as a set point. Browning of this amount will render a surfactant unsuitable for use as a surfactant according to the present invention. Preferably surfactants which provide no change in flower petal morphology or color are selected for use in the present compositions.

Carriers and Adjunct Ingredients

The polymers which comprise the first component of the present invention are suitably dissolved in a carrier which is effective in delivering the polymer as a homogeneous layer to the flower or plant surface. Non-limiting examples of carriers according to the present invention include water and an alcohol selected from the group consisting of methanol, ethanol, isopropanol, n-propanol, ethylene glycol, propylene glycol, and mixtures thereof; preferably a carrier comprising both water and an alcohol wherein the ratio of water to said alcohol is from about 99:1 to about 1:99.

The first component of the present invention may further comprise one or more adjunct ingredients. Preferred adjunct ingredients are selected from the group consisting of surfactants, fragrance raw materials, pro-fragrances, pro-accords, dye, colorants, and mixtures thereof.

Second Component

The second component of the moisture transpiration control systems of the present invention is a composition which is added to water to make up a solution into which is placed the stem of a plant or flower. The water to which the second component is added can be household water, i.e. tap water, preferably said water comprises less than 3 grains of calcium, more preferably said water is distilled water, most preferably distilled water which is treated to remove any exogenic microorganisms. At a minimum, the second component of the present invention comprises a source of energy for the cut flower or plant and an effective antimicrobial as described herein below.

Source of Energy

The second component of the present invention comprises a source of energy or nutrients for sustaining the viability cut plants or flowers during the display period. The compositions of the present invention, prior to said compositions being dissolved in water or other suitable carrier or mixtures of carriers and water, to form a solution, comprise from about 75% by weight, of a source of energy. Other embodiments of the present invention comprise from about 90% by weight, of a source of energy while yet another embodiment comprises from about 99% by weight, of a source of energy. The compositions described herein may also comprise up to about 99.95% by weight, of an energy source. Suitable sources of energy include saccharide, oligosaccharide, polysaccharide, etc., and mixtures thereof regardless of form, provided the source of energy has sufficient water solubility. For the purposes of the present invention the term "sugar" or "sugars" will stand equally well for saccharide, oligosaccharide, polysaccharide, and "reducing sugars, non-reducing sugars and the like". Non-limiting examples of sugars, which are a source of energy, suitable for any number of embodiments of the present invention, include aldopentoses such as ribose, arabinose, and xylose; aldohexoses such as allose, altrose, glucose, mannose, gulose, idose, galactose, and talose; ketohexoses such as fructose; monosaccharide derivatives such as alkyl- α -, alkyl- β -, aryl- α -, aryl- β -glycosides such as methyl- α -D-glucopyranoside and phenyl- α -D-glucopyranoside, and salicin; disaccharides such as lactose, maltose, cellobiose, gentiobiose, turanose, isomaltose, laminaribose, melibiose, sucrose, and trehalose; and trisaccharides such as raffinose and gentianose. Examples of easily available and inexpensive source of energy include

glucose and sucrose. Glucose is utilized by many of the embodiments described herein as a non-limiting example of a source of energy.

When complex sugars are taken into the plant, they are split into their constituent units, for example, sucrose into glucose and fructose, which results in a concentration gradient which further enhances the uptake of moisture.

When microbes are allowed to grow in the vase water into which cut plants or flowers are placed, the microbes will occlude the xylem of the plant stem and abate the uptake of moisture and nutrients into the flower or plant leaves and petals. The present invention comprises one or more anti-microbial compounds which serve to abate the obstruction of fluid and source of energy uptake into the cut flower or plant. The compositions of the present invention comprise an "effective amount" of an anti-microbial or anti-microbial system. An anti-microbial system is defined herein as two or more anti-microbial compounds. The term "effective amount" is defined herein as the amount of an anti-microbial or anti-microbial system sufficient to abate the growth of microbes which act to occlude the uptake of nutrients by the cut flower or plant.

Embodiments of the present invention include final aqueous solutions comprising from about 1 ppm (0.0001%) with upper limits of from 100 ppm (0.01%) to 200 ppm (0.02%) by weight. Indeed, other embodiments comprise from about 5 ppm (0.0005%) to to ranges of about 50 ppm (0.005%) to about 100 ppm (0.01%) by weight, of an antimicrobial. When expressed as non-aqueous, granular compositions, or compositions prior to dissolving into a liquid carrier, comprise from about 0.1% on a dry weight basis of one or more anti-microbial compounds. Another embodiment comprises from about 1% on a dry weight basis, of one or more anti-microbial compounds.

Embodiments of the present invention include granular compositions comprising from about 100 ppm (0.01%) with upper limits of from 10,000 ppm (1%) to 20,000 ppm (2%) by weight. Indeed, other embodiments comprise from about 500 ppm (0.05%) to to ranges of about 5000 ppm (0.5%) to about 10,000 ppm (1%) by weight, of an antimicrobial. When expressed as non-aqueous, granular compositions, or compositions prior to dissolving into a liquid carrier, comprise from about 0.01% on a dry weight basis of one or more anti-microbial compounds. Another embodiment comprises from about 0.05% to about 0.1% on a dry weight basis, of one or more anti-microbial compounds.

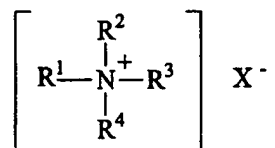
The compositions of the present invention may also comprise antimicrobial systems which are a combination of two or more antimicrobials. Said systems will afford the formulator with the

ability to target certain species of microorganisms which are characteristic of a specific plant species.

As a non-limiting example, an final aqueous solution which comprises 1% by weight, of a source of energy and 250 ppm (0.025%) of one of more anti-microbial compounds is formed from a dry (granular) composition comprising:

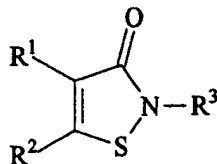
- i) about 97.6% by weight, of a source of energy; and
- ii) about 2.4% by weight, of an antimicrobial system.

One type of anti-microbial compounds are quaternary ammonium compounds having the formula:



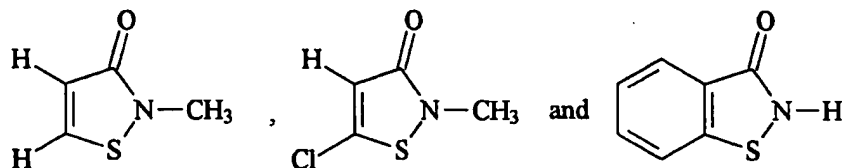
wherein R^1 and R^2 are each independently C_8 - C_{20} linear or branched alkyl, benzyl, and mixtures thereof, preferably R^1 and R^2 are each C_{12} alkyl; or alternatively one of R^1 and R^2 is a mixture of n-alkyl units, *inter alia*, C_{12} , C_{14} , and C_{16} , and one of R^1 and R^2 is benzyl; R^3 and R^4 are each independently C_1 - C_4 alkyl, and mixtures thereof, preferably R^3 and R^4 are each methyl; X is an anion of sufficient charge to provide electronic neutrality, preferably halogen, more preferably chlorine. Non-limiting examples of preferred antimicrobial is didodecyl dimethylammonium chloride and the admixture of C_{12} , C_{14} , and C_{16} n-alkyl, benzyl dimethyl ammonium chlorides ex Lonza.

Another type of antimicrobial includes isothiazolones having the formula:



wherein R^1 and R^2 are each independently hydrogen, alkyl, alkenyl, halogen, cyano, and mixtures thereof or R^1 and R^2 can be taken together to form an aromatic or non-aromatic, heterocyclic or non-heterocyclic ring. R^3 is hydrogen, alkyl, and mixtures thereof. A preferred R^3 is methyl.

Non limiting examples of suitable isothiazolones include:



which can be combined, as in the case of Kathon® CG/ICP II ex Rohm and Haas (added embodiment) which is a combination of 2-methylisothiazol-3-one and 2-methyl-5-chloroisothiazol-3-one. Another preferred anti-microbial, 1,2-benzisothiazolin-3-one, is sold under the name Proxel® GXL ex Zeneca. Anti-microbial of this class can be used at a level of from about 0.1 ppm (0.00001%), in other embodiments from about 1 ppm (0.0001%). The upper range of antimicrobials can be up to about 20 ppm (0.002%), yet other embodiments may limit this upper range to about 10 ppm (0.001%) by weight, of the final aqueous solution which serves as the vase solution.

Buffers and Buffer Systems

The compositions of the present invention when used, have an acidic pH. What is meant herein by acidic pH is a pH which is lower than 7, or which has some amount of hydrogen ion present. Particularly useful embodiments have a pH of between 2 and about 5. Some embodiments are more narrow in range, that is from about 3 to about 4 or from about 2 to about 3.5. The final pH range will be predicated on several factors including the selection of buffers or buffer systems, the type of embodiment and the scope of the formulators composition.

The aqueous compositions of the present invention comprise in one embodiment from about 0.0001% (1 ppm) by weight, of said buffer. Other embodiments comprise from 0.001% (10 ppm) to about 0.1% (1000 ppm) by weight, of said buffer. A particular embodiment comprises from about 0.01% (100 ppm) to about 0.016% (160 ppm) by weight, of a buffer system.

For dry granular compositions which are to be dissolved in a suitable carrier, an embodiment comprises from about 0.98% by weight, of a buffer. Other embodiments comprise from 2% to about 10% by weight, of a buffer. A particular embodiment comprises from 1.5 to 2% by weight, of said buffer.

Organic acid buffers and buffering systems may be used by the formulator as well as buffers and buffering systems which derive from inorganic acids. For example, citric acid may be used directly as a buffer, or in another embodiment, a citric acid/sodium citrate admixture may be used to create specific system. Sodium hydrogen phosphate/disodium hydrogen phosphate buffer systems are also suitable for the present invention.

Non-limiting examples of suitable acids include those selected from the group consisting of citric acid, itaconic acid, malonic acid, maleic acid, caffeic acid, succinic acid, adipic acid, sebacic acid, and salts thereof. Of course, the free acid and salts may be added as admixtures and admixtures of any acids and acid salts can be employed.

Adjunct ingredients

The compositions of the present invention can optionally comprise one or more adjunct ingredients. A preferred adjunct ingredient according to the present invention is a calcium chelant or calcium sequestrant. Non-limiting examples of calcium sequestrants include sodium tripolyphosphate, finely divided zeolite including zeolite A, zeolite X, and zeolite Y, ethylenediamine, and mixtures thereof. A further example of a preferred adjunct ingredient is selected from the group consisting of surfactants, fragrance raw materials, pro-fragrances, pro-accords, dye, colorants, and mixtures thereof. Suitable pro-fragrances and pro-accords are described in U.S. 5,919,752 Morelli et al., issued July 6, 1999; U.S. 5,756,827 Sivik, issued May 26, 1998; U.S. 5,744,435 Hartman et al., issued April 25, 1998; and U.S. 5,965,767 Sivik et al., issued October 12, 1999 all of which are incorporated herein by reference.

The compositions of the present invention are not restricted to preserving cut flowers and plants but are also useful in extending the life of harvested fir trees, *inter alia*, for use as Christmas trees, or the cuttings taken from branches for use as adornment. Coniferous trees, typically, firs which are placed in the home as adornments during Christmas are subject to dehydration and are, therefore, prone to dropping their needles and becoming a fire hazard. Therefore, a preferred adjunct ingredient which can be added to fir tree compositions are compounds which serve as a fire retardant. The compositions of the present invention can be used to extend the life of fir trees which are harvested for holiday decorations. Palm fronds as well as ferns may also have their aesthetic life extended by the compositions of the present invention.

In one aspect of the present invention, the compositions are prepared as dry, powdered mixtures which are stored and shipped as such and dissolved in water immediately prior to use as cut flower preservative solutions. When in the form of dry powders, the formulations of this invention are packaged in bulk for end use, as in containers having a tightly-fitting lid such as screw-capped or snap-capped bottles or, preferably are packaged in plastic or foil packets containing the required amount of material for a single use.

In one aspect of the present invention, the compositions are prepared as dry, powdered mixtures which are stored and shipped as such and dissolved in water immediately prior to use as

cut flower preservative solutions. When in the form of dry powders, the formulations of this invention are packaged in bulk for end use, as in containers having a tightly-fitting lid such as screw-capped or snap-capped bottles or, preferably are packaged in plastic or foil packets containing the required amount of material for a single use.

A dry composition comprising 99.5% by weight, glucose and the balance an anti-microbial, when 1 gm of said dry composition is dissolved in 1 liter of distilled water will provide approximately 0.1% by weight, of a source of energy and approximately 5 ppm of said anti-microbial. The formulations of the compositions, depending upon the relative levels of components, are dissolved in water just prior to use at a concentration ranging from about to about 20 g/liter. Other embodiments can range from 1 g/liter to about 15 g/liter. Yet other embodiments range from about 5 g/liter or from about 7 g/liter to about 10 g/liter. For a typical arrangement of cut flowers, the volume of water in a vase is about one-half to one liter. Therefore, a preferred package of the second component of the present invention is a foil or plastic packet containing about 2.5 grams to 3 grams of material.

The following are non-limiting examples of the systems which comprise the present invention.

TABLE I

weight %

Ingredients	1	2	3	4
First Component (SPRAY)				
Copolymer ¹	2.5	--	--	--
Copolymer ²	--	2.2	--	--
Copolymer ³	--	--	2.9	--
Copolymer ⁴	--	--	--	1.8
Surfactant ⁵	0.1	0.1	0.1	0.1
Carrier ⁶	balance	balance	balance	balance
Percent acid residues neutralized	10	10	10	12
Second Component (VASE)				
Source of energy ⁷	1.0	1.0	--	--
Source of energy ⁸	--	--	1.5	--
Source of energy ⁹	--	--	--	1.25

Antimicrobial ¹⁰	0.01	0.01	0.025	0.025
Antimicrobial ¹¹	0.01	0.01	--	--
Antimicrobial ¹²	0.005	0.005	--	--
Calcium sequestrant ¹³		1.0	--	1.0
Carrier ¹⁴	balance	balance	balance	balance

1. Reaction product of:
 - i) about 43% by weight, of methyl methacrylate;
 - ii) about 47% by weight, of butyl acrylate; and
 - iii) about 10% by weight, of acrylic acid.
2. Reaction product of:
 - i) about 40% by weight, of methyl methacrylate;
 - ii) about 47% by weight, of butyl acrylate; and
 - iii) about 13% by weight, of acrylic acid.
3. Reaction product of:
 - i) about 43% by weight, of methyl methacrylate;
 - ii) about 45% by weight, of butyl acrylate; and
 - iii) about 12% by weight, of acrylic acid.
4. Reaction product of:
 - i) about 43% by weight, of methyl methacrylate;
 - ii) about 43% by weight, of butyl acrylate; and
 - iii) about 14% by weight, of acrylic acid.
5. Disodium lauroampho diacetate available ex Rhodia as Miranol[®] Ultra 32.
6. 80% distilled water, 20% SD-3A alcohol ex J. T. Baker.
7. Sucrose.
8. Glucose.
9. Isomaltose.
10. Didodecyl dimethylammonium chloride.
11. Admixture of C₁₂, C₁₄, and C₁₆ n-alkyl, benzyl dimethyl ammonium chlorides ex Lonza.
12. 1,2-Benzisothiazolin-3-one sold under the name Proxel[®] GXL ex Zeneca.
13. Sodium tripolyphosphate.
14. Distilled water.

The following are non-limiting examples of Vase additive solutions.

TABLE II

weight %

Ingredients	5	6	7	8
Source of energy ¹	1.0	1.0	--	--
Source of energy ²	--	--	1.5	--
Source of energy ³	--	--	--	1.25
Antimicrobial ⁴	0.01	0.01	0.025	0.025
Antimicrobial ⁵	0.01	0.01	--	--
Antimicrobial ⁶	0.005	0.005	--	--
Calcium sequestrant ⁷		1.0	--	1.0
Carrier ⁸	balance	balance	balance	balance

1. Sucrose.
2. Glucose.
3. Isomaltose.
4. Didodecyl dimethylammonium chloride.
5. Admixture of C₁₂, C₁₄, and C₁₆ n-alkyl, benzyl dimethyl ammonium chlorides ex Lonza.
6. 1,2-Benzisothiazolin-3-one sold under the name Proxel[®] GXL ex Zeneca.
7. Sodium tripolyphosphate.
8. Distilled water.

TABLE III

weight %

Ingredients	9	10	11	12
Source of energy ¹	1.0	1.0	--	--
Source of energy ²	--	--	1.5	--
Source of energy ³	--	--	--	1.25
Antimicrobial ⁴	0.001	0.001	0.001	0.001
Calcium sequestrant ⁵		1.0	--	1.0
Carrier ⁶	balance	balance	balance	balance

1. Sucrose.

2. Glucose.
3. Isomaltose.
4. Kathon ICP/CG II (Rohm & Haas).
5. Sodium tripolyphosphate.
6. Distilled water.

TABLE IV

weight %

Ingredients	13	14	15	16
Source of energy ¹	0.75	1.0	1.5	2.0
Antimicrobial ²	0.001	0.001	0.001	0.001
Antimicrobial ³	0.004	0.004	0.004	0.004
Citric acid	0.01	0.01	0.01	0.01
Sodium Citrate	0.006	0.006	0.006	0.006
Carrier ⁴	balance	balance	balance	balance

1. Glucose.
2. Kathon[®] ICP/CG II (Rohm & Haas).
3. Bartac[®] 2250 (Lonza).
4. Distilled, de-ionized water.

TABLE V

weight %

Ingredients	17	18	19	20
Source of energy ¹	0.75	1.0	1.5	2.0
Antimicrobial ²	0.001	0.001	0.001	0.001
Antimicrobial ³	0.004	0.004	0.004	0.004
Citric acid	0.01	0.01	0.01	0.01
Sodium Citrate	0.006	0.006	0.006	0.006
Carrier ⁴	balance	balance	balance	balance

1. Glucose.
2. Niolone[®] M-50 (Rohm & Haas).

3. Bartac® 2250 (Lonza).
4. Distilled, de-ionized water.

TABLE VI

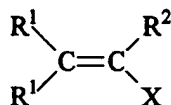
weight %

Ingredients	21	22	23	24
Source of energy ¹	0.75	1.0	1.5	2.0
Antimicrobial ²	0.001	0.001	0.001	0.001
Antimicrobial ³	0.004	0.004	--	--
Antimicrobial ⁴	--	--	0.004	0.004
Citric acid	0.01	0.01	0.01	0.01
Sodium Citrate	0.006	0.006	0.006	0.006
Carrier ⁵	balance	balance	balance	balance

1. Glucose.
2. Kathon® ICP/CG II (Rohm & Haas).
3. Bartac® 2050 (Lonza).
4. Bartac® LF-80 (Lonza).
5. Distilled, de-ionized water.

What is claimed is:

1. A system for controlling plant and flower moisture transpiration, said system comprising:
 - a) a first component in the form of a solution, said solution applied to the surface of a plant or flower exposed to air, said first component comprising:
 - i) from 0.1% to 20% by weight, of a polymer of copolymer comprising monomers having the formula:



wherein each R¹ is independently hydrogen, C₁-C₁₂ alkyl, C₁-C₁₂ alkoxy, phenyl, substituted phenyl, benzyl, substituted benzyl, carbocyclic, heterocyclic, and mixtures thereof; R² is hydrogen, halogen, C₁-C₁₂ alkyl, C₁-C₁₂ alkoxy, phenyl, substituted phenyl, benzyl, substituted benzyl, carbocyclic, heterocyclic, and mixtures thereof; X is hydrogen, hydroxyl, halogen, -(CH₂)_mCH₂OH, -(CH₂)_mCOR, -(CH₂)_mCH₂OCOR', wherein R is -OR', -N(R')₂, -(CH₂)_nN(R'')₂, and mixtures thereof; each R' is independently hydrogen, C₁-C₈ alkyl, C₂-C₈ hydroxyalkyl, -(CH₂)_nN(R'')₂, and mixtures thereof; wherein R'' is independently hydrogen, C₁-C₄ alkyl, and mixtures thereof; the index m is from 0 to 6, the index n is from 2 to 6;

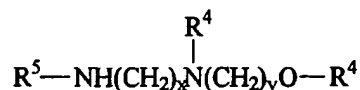
- ii) from 0.01% to 5% by weight, of a surfactant;
 - iii) the balance carriers and other adjunct ingredients; and
- b) a second component comprising:
 - i) from 0.1% by weight, of a source of energy;
 - ii) from 5 ppm by weight, of one or more antimicrobials; and
 - iii) the balance carriers and adjunct ingredients;

wherein said second component is dissolved in water to form a solution and into which solution is placed the plant or flower to be preserved.

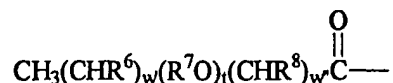
2. A composition according to Claim 1 wherein said copolymer comprises two or more monomers selected from the group consisting of ethylene, propylene, butylene, styrene,

vinyl alcohol, crotyl alcohol, acrylic acid, styrylacetic acid, methacrylic acid, crotonic acid, 3,3-dimethyl-acrylic acid, methyl acrylate, ethyl acrylate, n-propyl acrylate, isopropyl acrylate, butyl acrylate, methyl methacrylate, ethyl methacrylate, n-propyl methacrylate, isopropyl methacrylate, butyl methacrylate, methyl 3,3-dimethyl-acrylate, ethyl 3,3-dimethyl-acrylate, n-propyl 3,3-dimethylacrylate, isopropyl 3,3-dimethyl-acrylate, butyl 3,3-dimethyl-acrylate, acrylamide, N-methyl acrylamide, N,N-dimethyl acrylamide, N-(aminoethyl) methyl acrylamide, and mixtures thereof.

3. A composition according to either Claim 1 or 2 wherein said copolymer is selected from the group consisting of:
 - a) a co-polymer comprising
 - i) from 20% to 60% by weight, of methyl methacrylate;
 - ii) from 20% to 60% by weight, of butyl acrylate;
 - iii) from 0.5% to 20% by weight, of acrylic acid; and
 - b) a copolymer comprising;
 - i) from 40% to 50% by weight, of methyl methacrylate;
 - ii) from 40% to 50% by weight, of butyl acrylate; and
 - iii) from 5% to 15% by weight, of acrylic acid.
4. A composition according to any of Claims 1-3 wherein from 5% to 20% of said acrylic acid units are neutralized.
5. A composition according to any of Claims 1-4 wherein said surfactant has the formula:

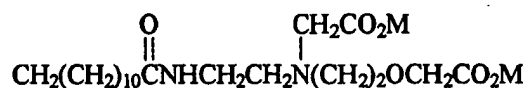


wherein R^4 is $\text{-(CH}_2\text{)}_z\text{CO}_2\text{M}$, $\text{-(CH}_2\text{)}_z\text{SO}_3\text{M}$, $\text{-(CH}_2\text{)}_z\text{OSO}_3\text{M}$, $\text{-(CH}_2\text{)}_z\text{PO}_3\text{M}$, and mixtures thereof; M is hydrogen or a salt forming cation; x and y are each independently an integer from 2 to 6; z is from 1 to 10; R^5 is an acyl unit having the formula:

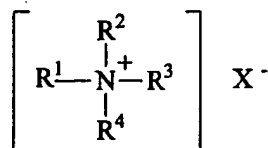


wherein R^6 and R^8 are each independently hydrogen, C_1 - C_4 alkyl, and mixtures thereof; R^7 is C_2 - C_{12} alkylene; t is from 0 to 10; the indices w' and w'' are each independently from 0 to 14, $w' + w'' =$ at least 6.

6. A composition according to any of Claims 1-5 wherein said surfactant has the formula:



7. A composition according to any of Claims 1-6 comprising from 0.05% to 2% by weight, of said surfactant
8. A composition according to any of Claims 1-7 wherein said source of energy comprises a saccharide, oligosaccharide, polysaccharide, or mixtures thereof.
9. A composition according to any of Claims 1-8 wherein said source of energy is glucose.
10. A composition according to any of Claims 1-9 wherein said antimicrobial is an antimicrobial system comprising:
- i) from 1% to 99% by weight, of said system, of one or more isothiazolone antimicrobials selected from the group consisting of 2-methyl-4-isothiazolin-3-one, 5-chloro-2-methyl-4-isothiazolin-3-one, and mixtures thereof;
 - ii) from 1% to 99% by weight, of said system, of one or more antimicrobials having the formula:



wherein R^1 and R^2 are each independently C_8 - C_{20} linear or branched alkyl, benzyl, and mixtures thereof; R^3 and R^4 are each independently C_1 - C_4 alkyl, and mixtures thereof; X is an anion of sufficient charge to provide electronic neutrality.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 01/01202

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A01N3/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, BIOSIS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 094 845 A (DE LONG CHARLES F) 13 June 1978 (1978-06-13) the whole document	1-10
Y	WO 95 34199 A (ABBOTT LAB) 21 December 1995 (1995-12-21) the whole document	1-10

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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Date of the actual completion of the international search

24 Apr 11 2001

Date of mailing of the international search report

02/05/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Bertrand, F

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internal Application No

PCT/US 01/01202

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